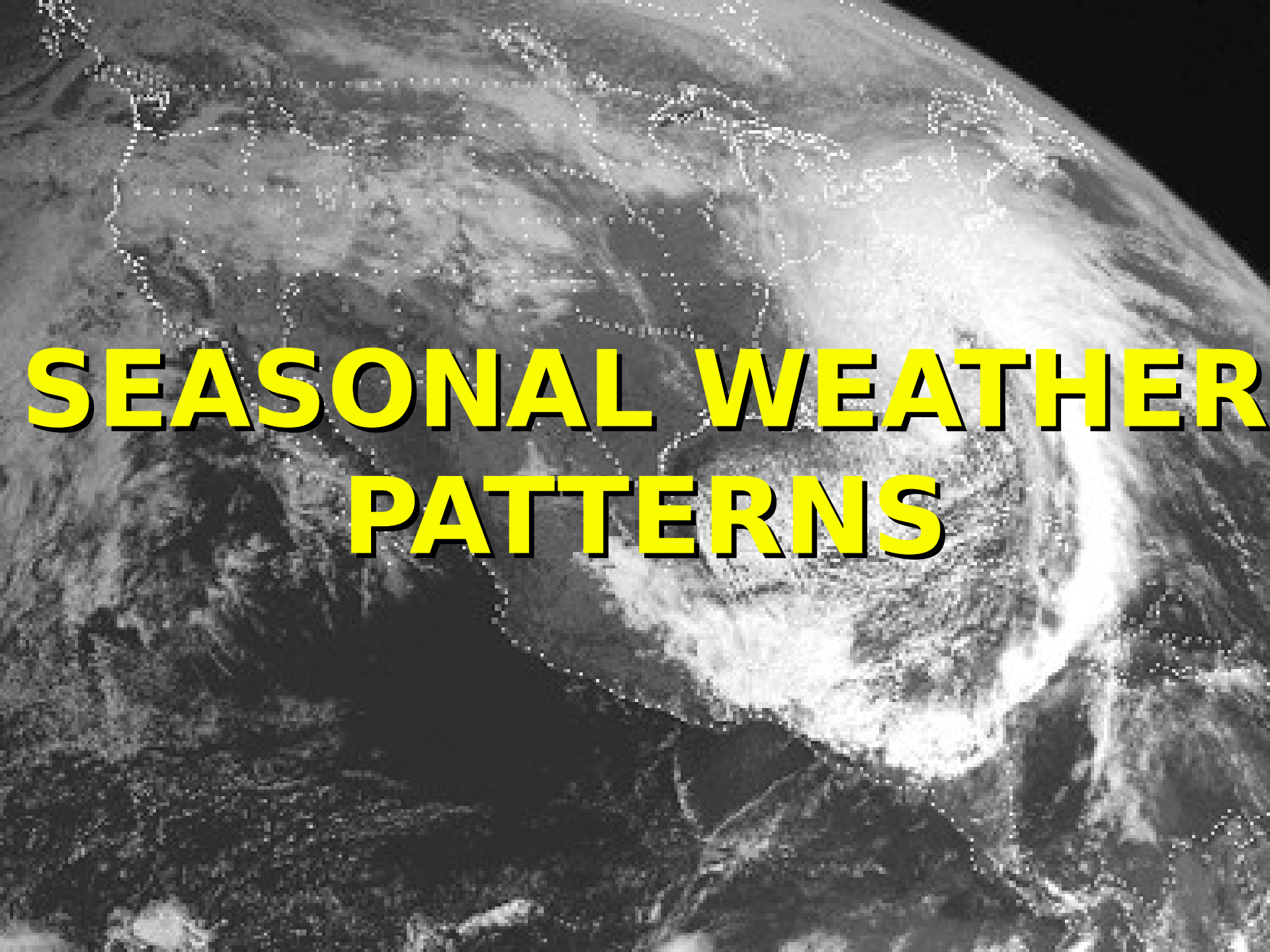
INSTRUMENT REFRESHER COURSE

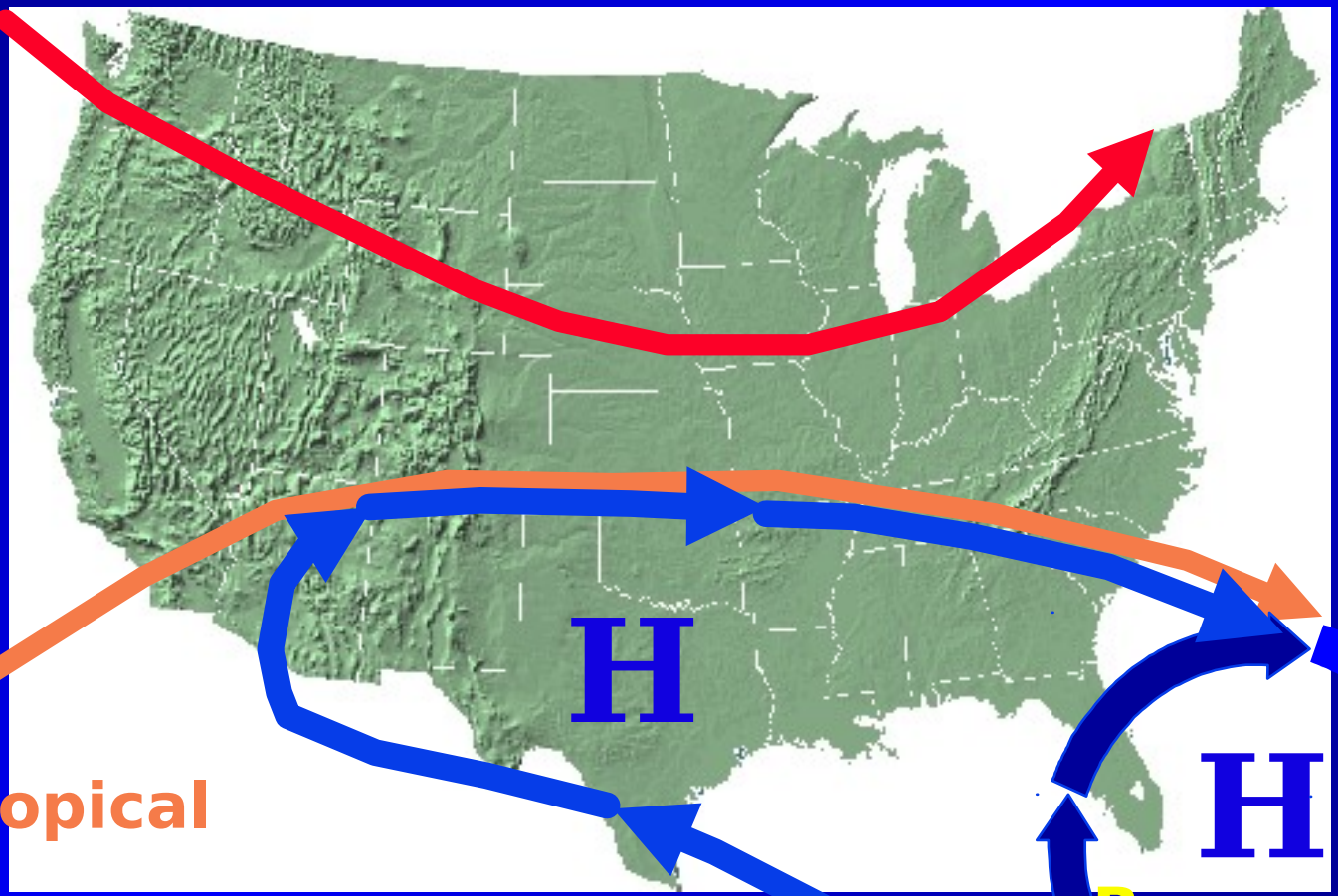
Presented by:
26 Operational Weather Squadron

OVERVIEW

- SEASONAL WEATHER PATTERNS
- HAZARDS
- WATCHES, ADVISORIES AND WARNINGS
- OBSERVING AND TAF CODING
- WEATHER EQUIPMENT & SOFTWARE


SEASONAL WEATHER
PATTERNS

SUMMER WEATHER PATTERN



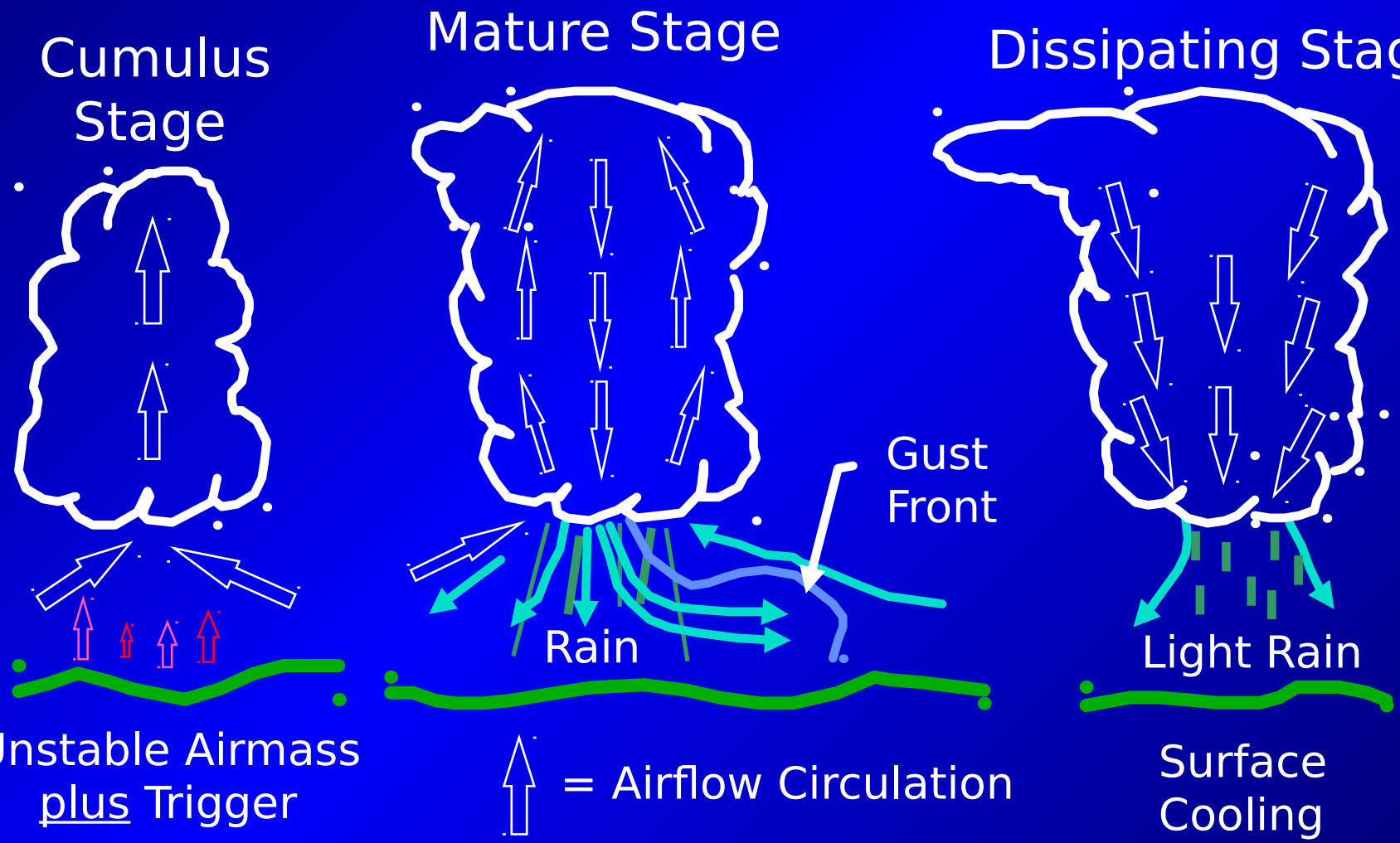
WINTER WEATHER PATTERN

HAZARDS

THUNDERSTORM HAZARDS

- ALL THUNDERSTORMS IMPLY:
  - TURBULENCE
  - ICING
  - STRONG WINDS and WIND SHEAR
  - LIGHTNING
- HAIL
  - OFTEN FOUND UNDER THE ANVIL
  - ENCOUNTERED AS HIGH AS 45,000 FT
  - MAY BE CARRIED UP TO 20 MILES DOWNWIND

THUNDERSTORM LIFE CYCLE



CUMULUS STAGE

Towering Cumulus

Sharply defined edges

More vertical extent than horizontal

MATURE STAGE

Cumulonimbus

Distinct anvil

Rain starts to fall

Lightning

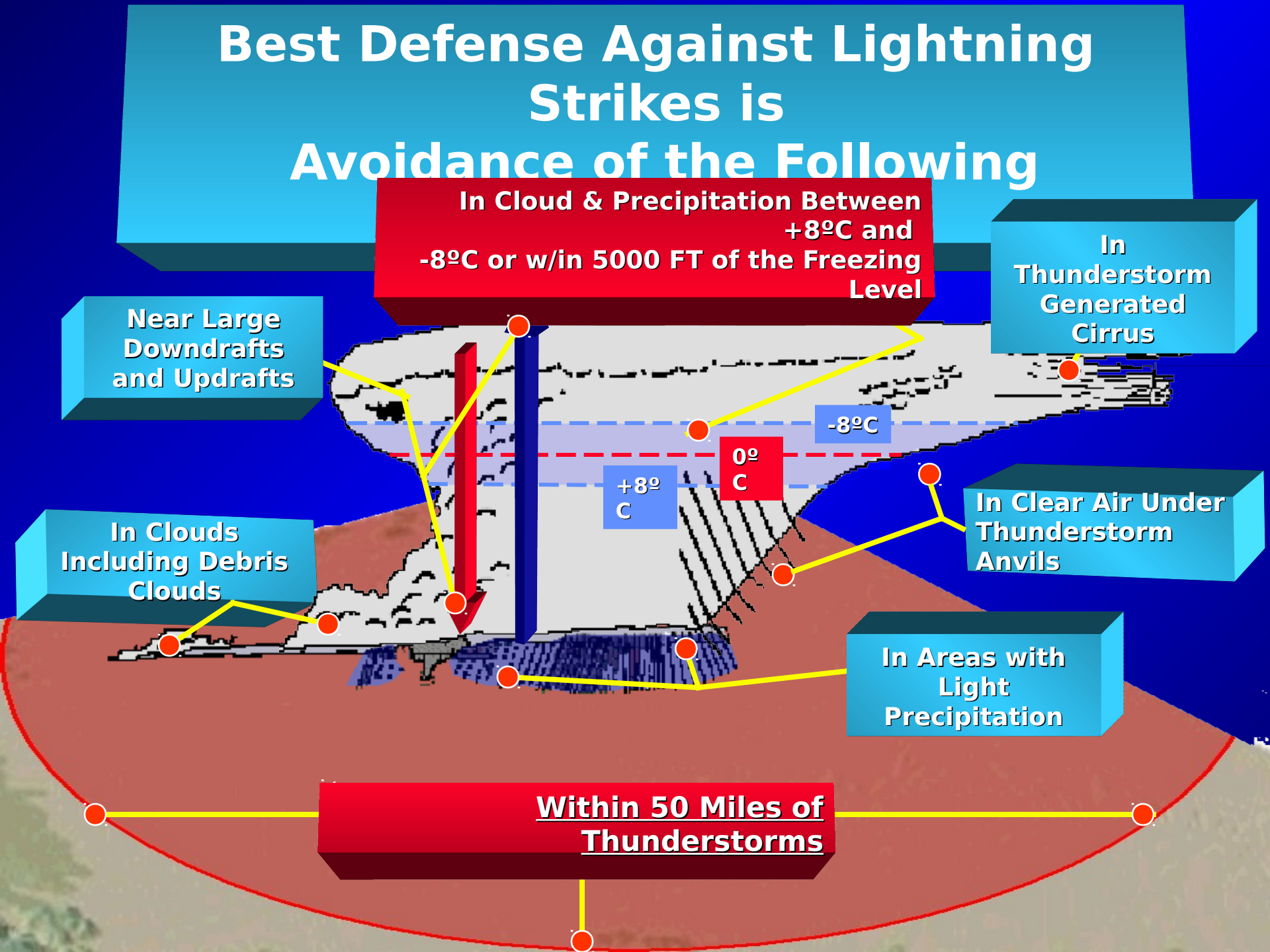
- *"Lightning Strikes and Electrostatic Discharges Are the **Leading Causes** of Reportable Weather-Related Aircraft Accidents and Incidents in the Air Force."Where most strikes occur:*

- Upper levels of thunderstorms, (temperatures < -40°C)
- Within 8°C of freezing level
- Within thick cirrus deck from decayed

LIGHTNING

- Flashes can occur up to 50 nm from a storm
- Most flashes within 5,000 ft of freezing level

Best Defense Against Lightning Strikes is Avoidance of the Following


In Cloud & Precipitation Between +8ºC and -8ºC or w/in 5000 FT of the Freezing Level
Near Large Downdrafts and Updrafts
In Thunderstorm Generated Cirrus
-8ºC
0º C
+8º C
In Clouds Including Debris Clouds
In Clear Air Under Thunderstorm Anvils
In Areas with Light Precipitation
Within 50 Miles of Thunderstorms

LIGHTNING

- EFFECTS ON AIRCREW : NONE TO DEATH

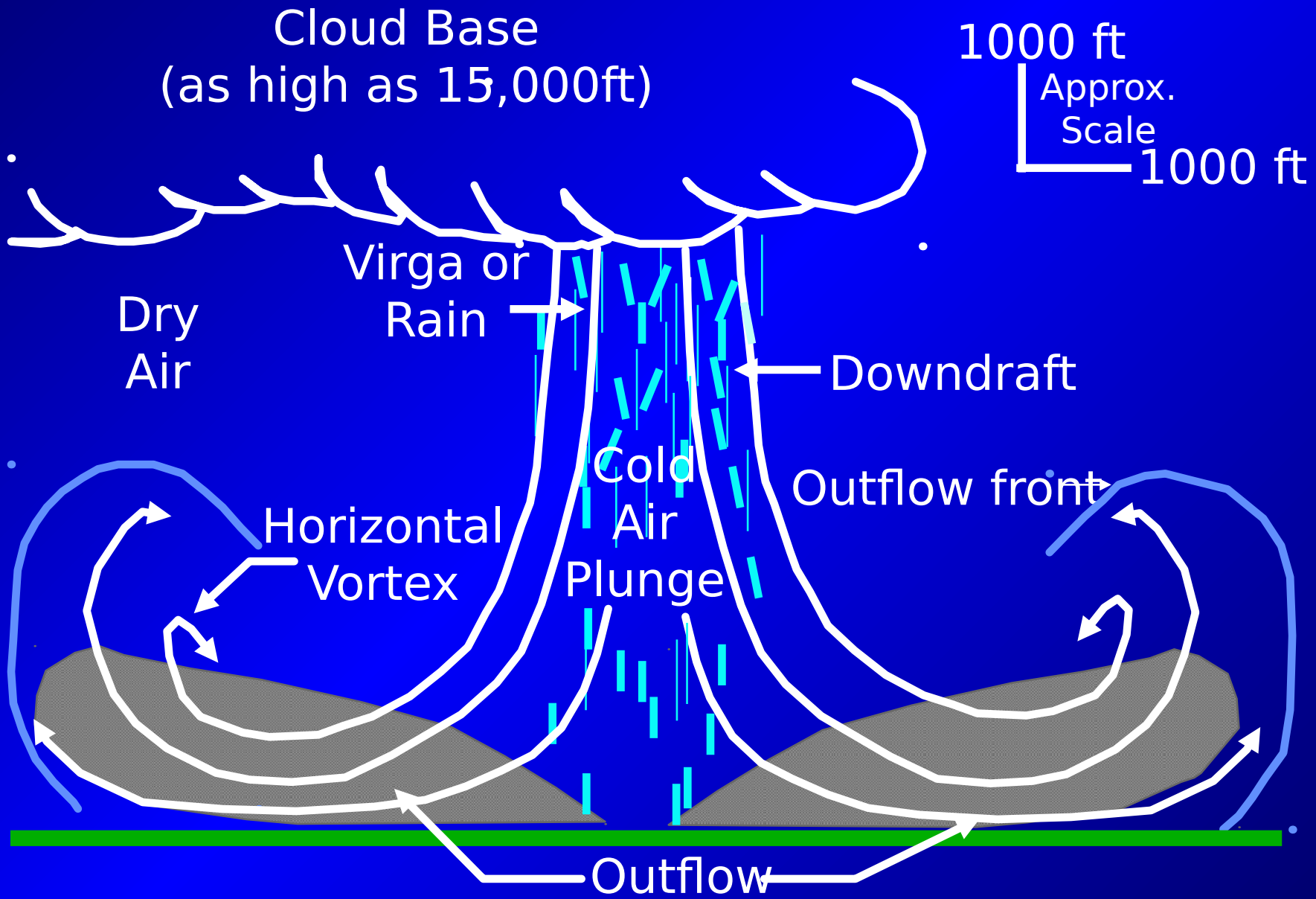
- EFFECTS ON AIRCRAFT:
  - FUSELAGE DAMAGE
  - MELTING AND DISTORTION OF METALLIC AND NON-METALLIC STRUCTURES
  - DAMAGE TO ELECTRICAL CIRCUITS
  - FUEL IGNITION
  - DISRUPTION OF NAVIGATIONAL SYSTEMS

Lightning Damage

Electrostatic Discharge

- Charges build up on aircraft when flying through particles (precipitation, dust, haze, and ice)
- Aircraft's electrical field may then interact with charged areas of atmosphere resulting in electrostatic discharge
- Usually cause minor physical damage and indirect effects such as electrical circuit upsets

MICROBURST FORMATION



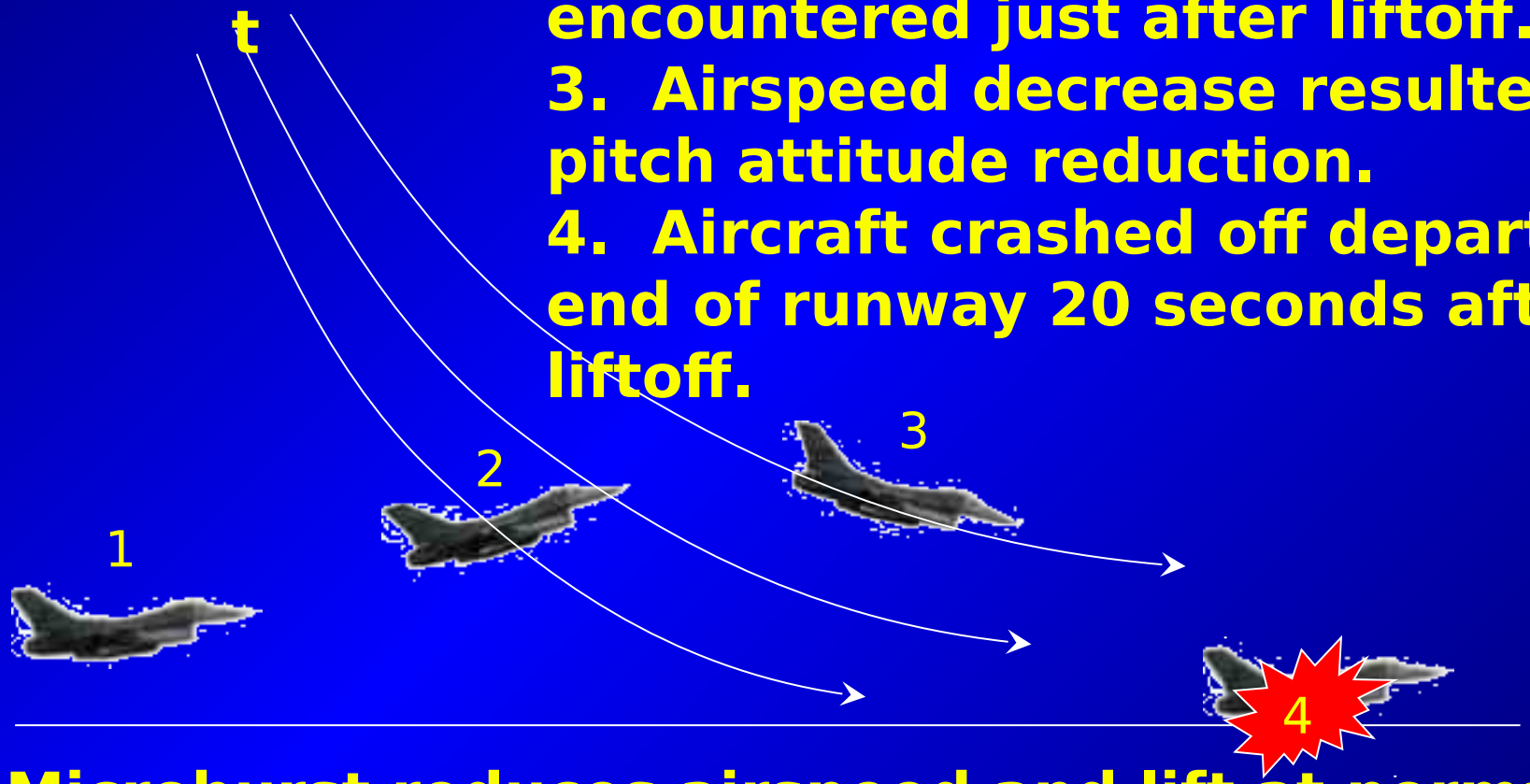
DURING TAKEOFF

1. Takeoff initially appeared normal.
2. Airspeed buildup slowed due to windshear.
3. Airplane reached takeoff speed near end of runway.
4. Aircraft contacted obstacle off departure end of runway.

Microburst reduces airspeed and lift at normal attitude that results in inability to liftoff.

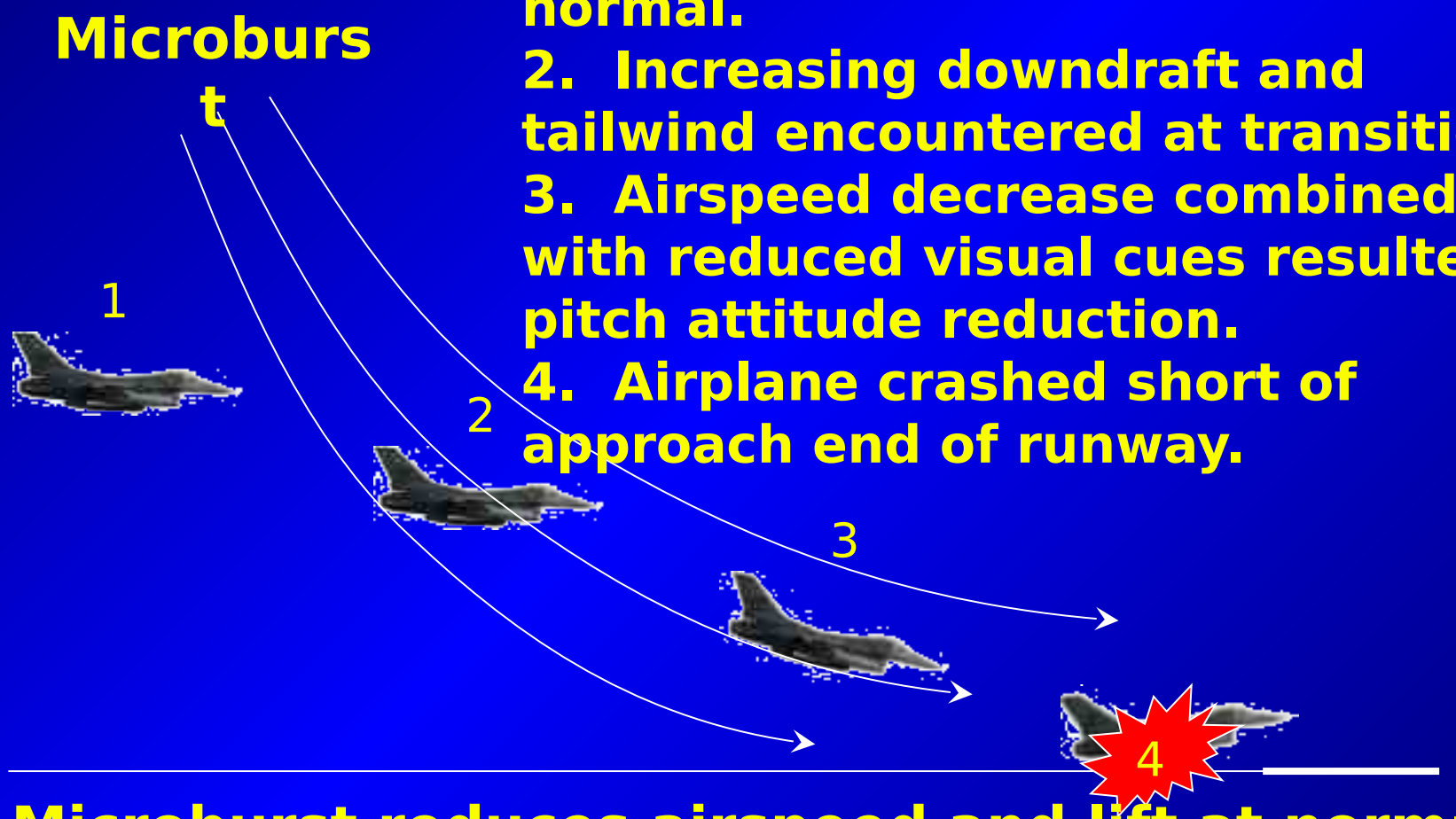
AFTER TAKEOFF

1. Takeoff initially appeared normal.
2. Windshear (microburst) encountered just after liftoff.
3. Airspeed decrease resulted in pitch attitude reduction.
4. Aircraft crashed off departure end of runway 20 seconds after liftoff.



Microburst reduces airspeed and lift at normal attitude which results in pitch down tendency to regain airspeed.

DURING APPROACH



1. Approach initially appeared normal.
2. Increasing downdraft and tailwind encountered at transition.
3. Airspeed decrease combined with reduced visual cues resulted in pitch attitude reduction.
4. Airplane crashed short of approach end of runway.

Microburst reduces airspeed and lift at normal attitude which results in pitch down tendency to regain airspeed.

HORIZONTAL VORTICES

Rapid updraft downdraft variations due to horizontal vortices can cause uncommanded pitch changes.

WET MICROBURST

Precipitation reaches the ground

Horizontal vortex

DRY MICROBURST

Precipitation evaporates--
Virga

Cloud base

DRY MICROBURST

Dust ring on surface

Wind Flow

Gust Front

MICROBURST

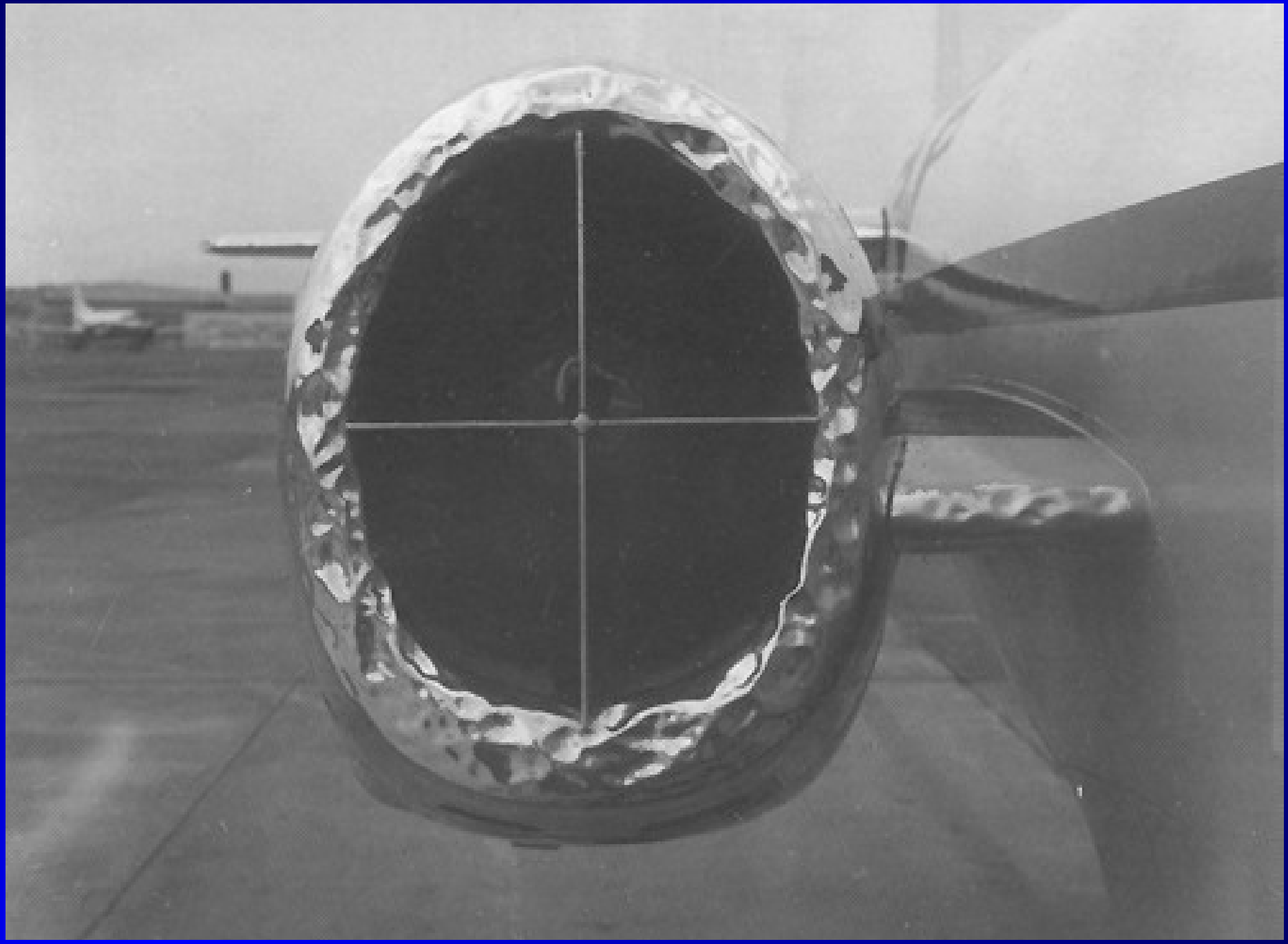
AVOID VIRGA

Oh Hail

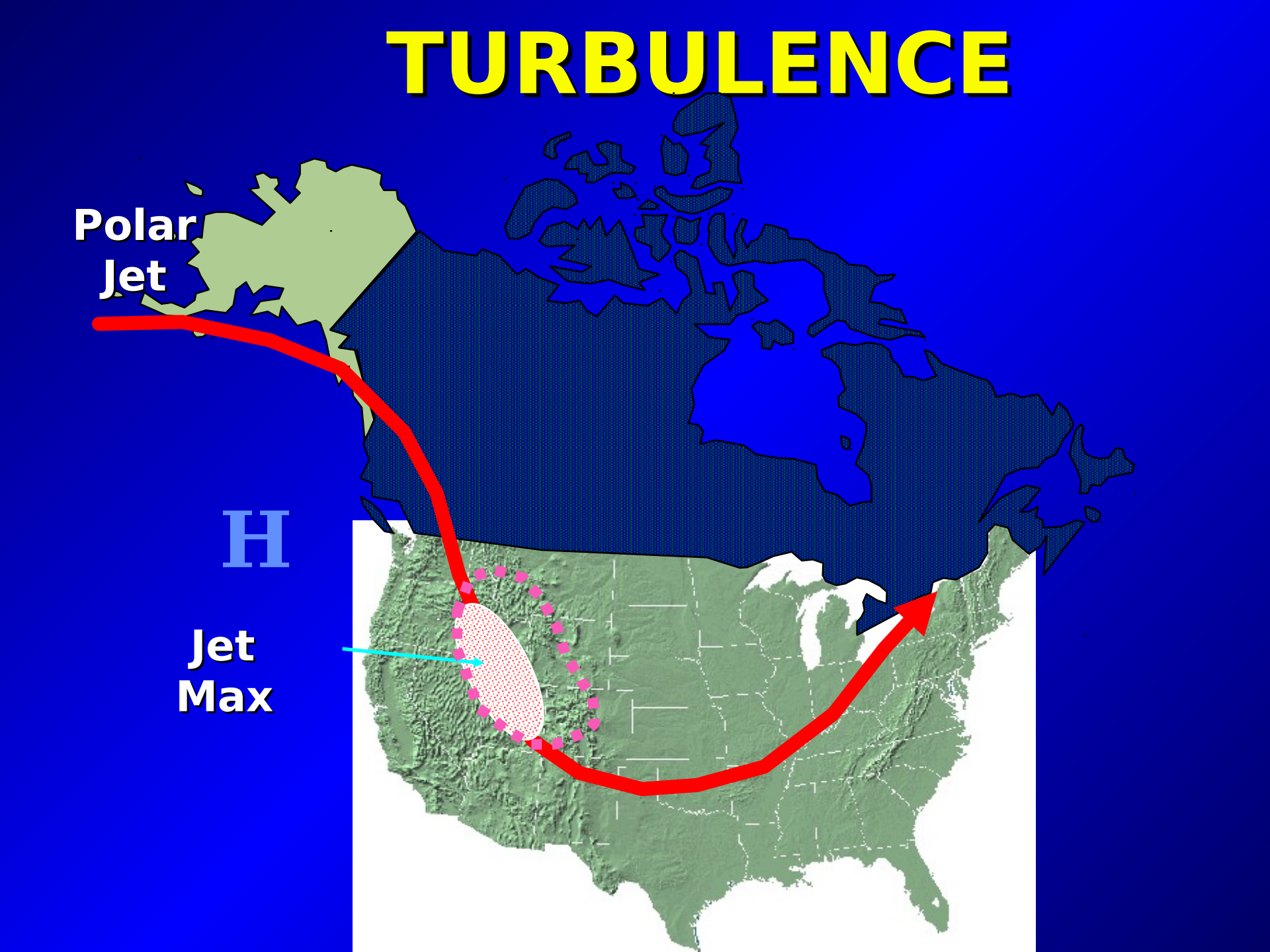
- The largest hailstone ever recorded, fell September 3, 1970 in Coffeyville, Kansas. It was 1.67 pounds, 7.5" in diameter, and 17.5" in circumference.

HAIL

- Most common in spring and early summer
- Larger at flight level



TURBULENCE



Types of Turbulence

- Convective
- Mechanical
- Mountain Wave
- Clear Air (High Altitude or Jet Stream)

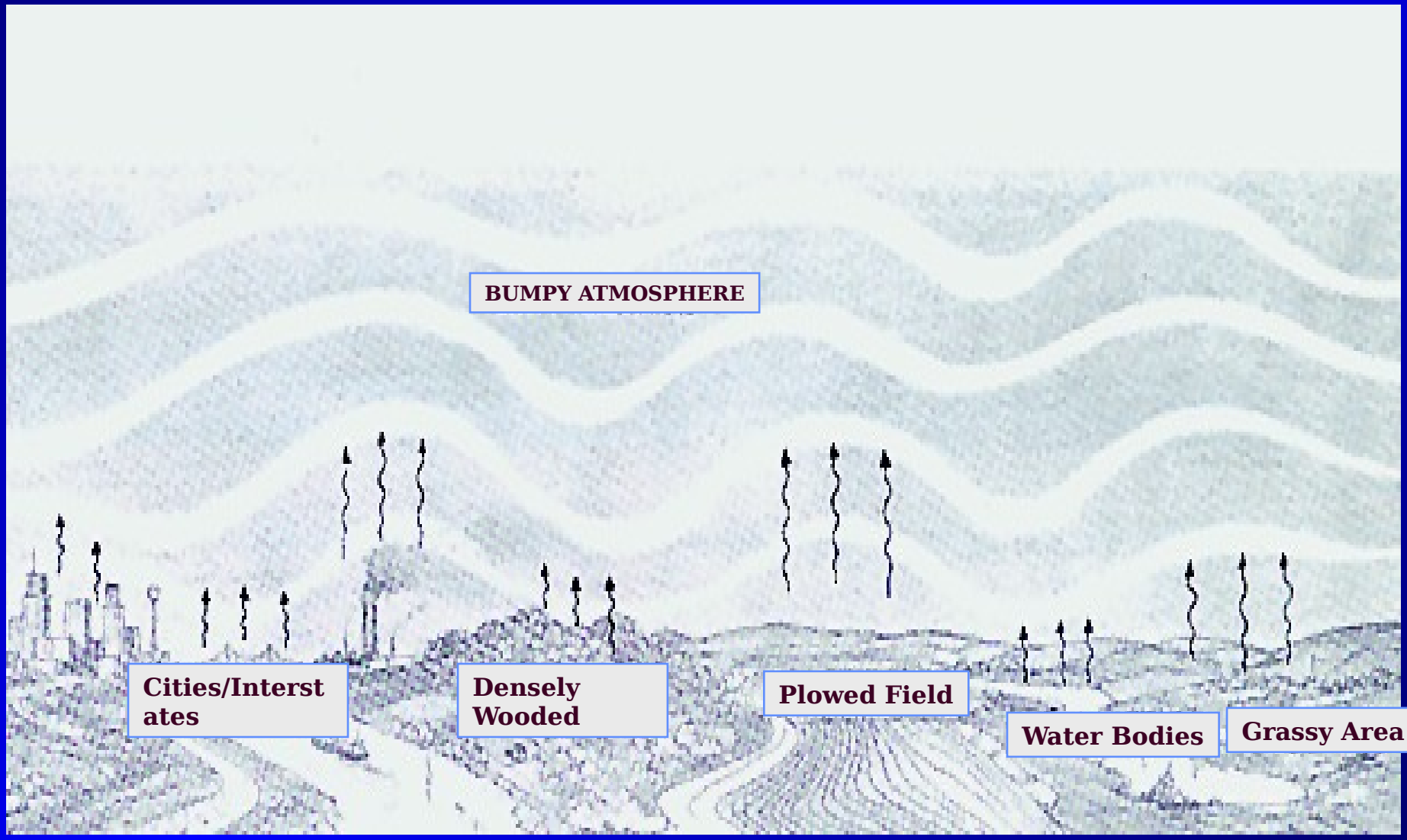
Convective Turbulence

- Caused by alternating currents of warm air rising and cooler air descending.

- Occurs most often during hot summer afternoons when surface winds are light.

  - –Its strength is directly proportional to the strength of heating.
  - –The affected area varies with terrain type.

Convective Turbulence

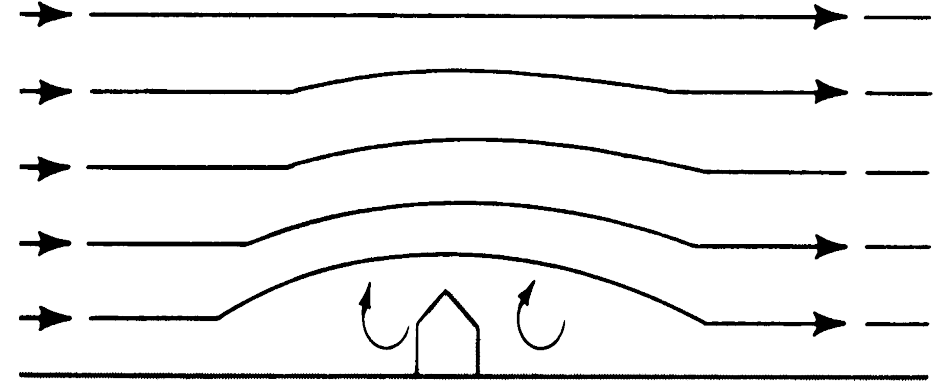


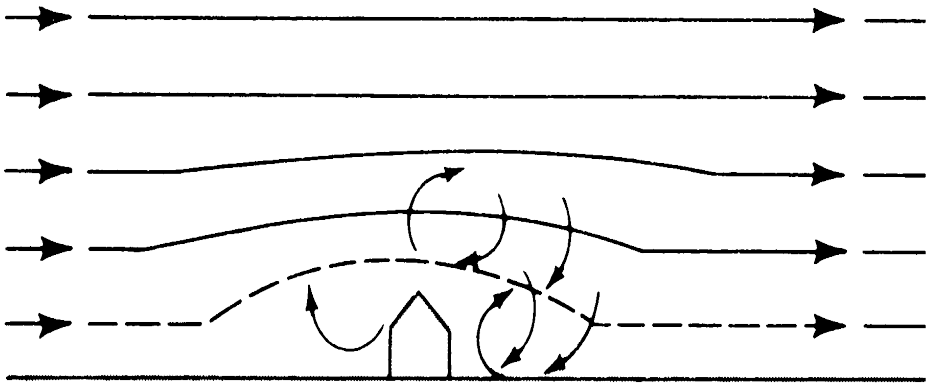
Convective Turbulence Avoidance

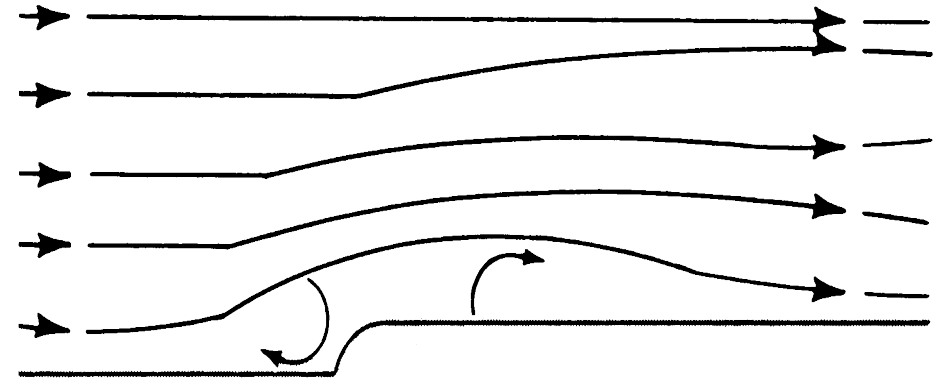
- Fly above the cloud level
- Anticipate its existence based on
  - the time of day
  - heating of different types of

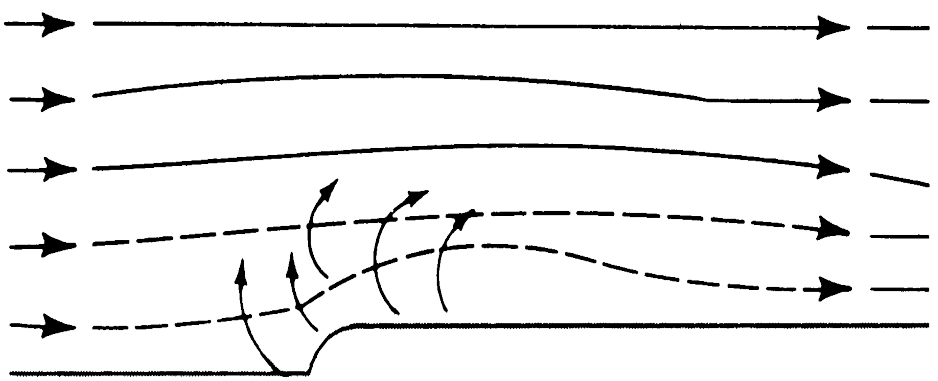
Mechanical Turbulence

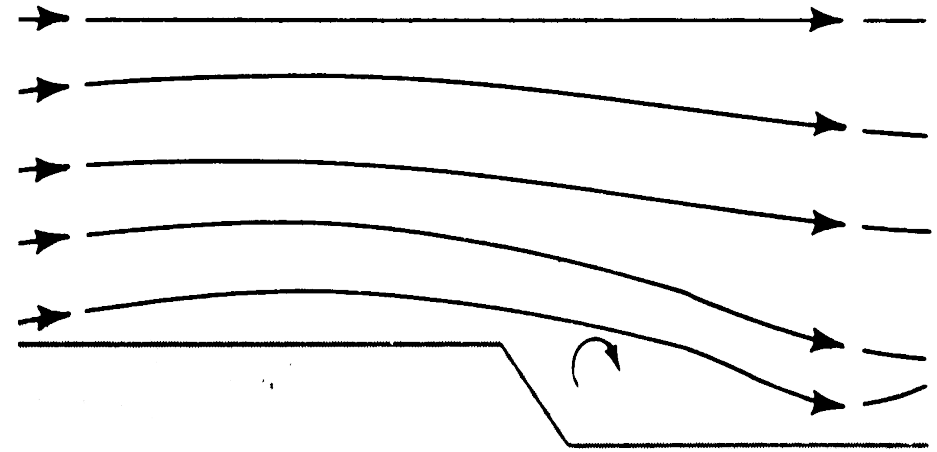
- Is caused by wind flowing over irregular terrain or obstruction, a marked change of wind speed, and/or direction in a short distance.
  - –Most often found near obstructions and rough surfaces.
  - –Its strength is directly proportional to the strength of the low level/surface wind and the roughness of the terrain.

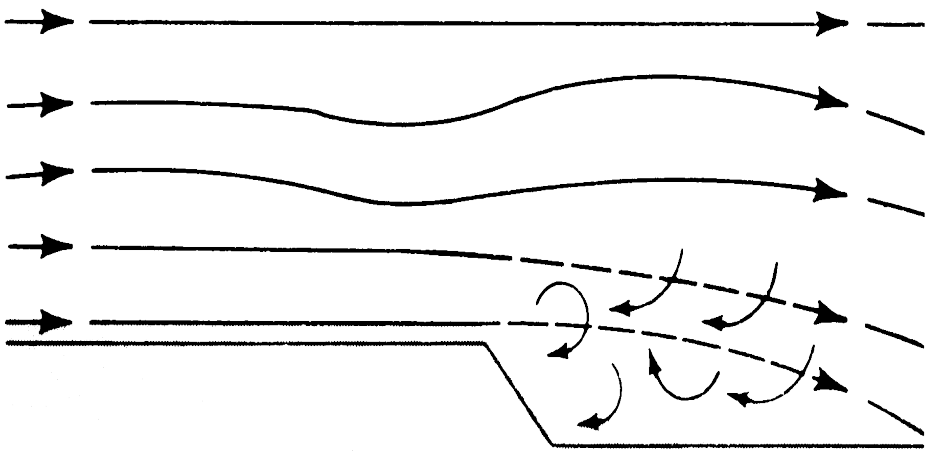












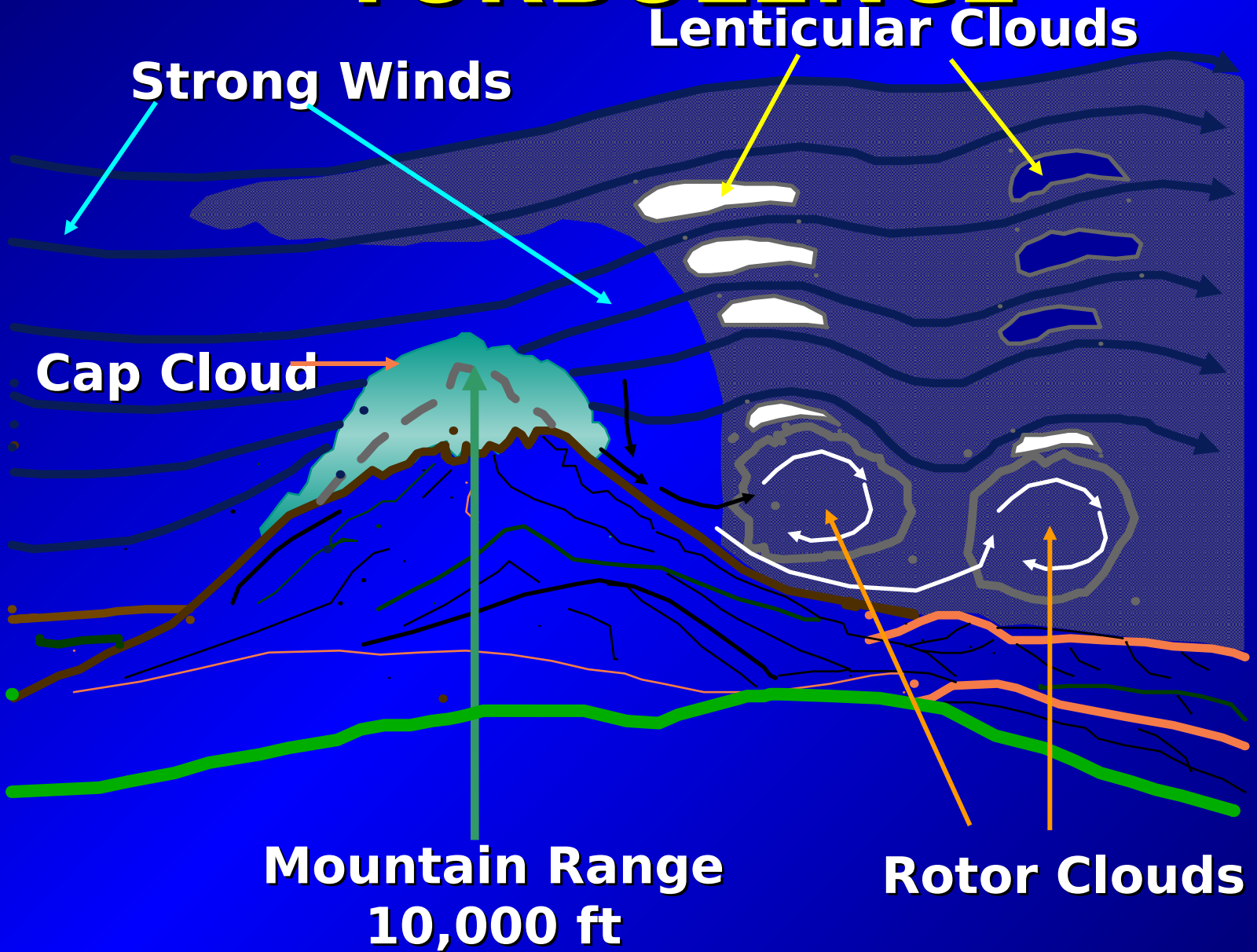
MOUNTAIN WAVE TURBULENCE

Lenticular Cloud

Mountain Wave Turbulence

- **Is caused when stable air blows perpendicular across the top of a mountain range.**
- **(>25 Knots)**
  - Its strength and affected area are related to the speed of the wind and the height the mountain extends into the stable layer.
  - Smooth air flowing up the windward side creates a leeward wave
- Note: Significant pressure altimeter errors are associated with mountain wave. The altimeter may indicate as much as 2,500’ higher than actual aircraft altitude!!

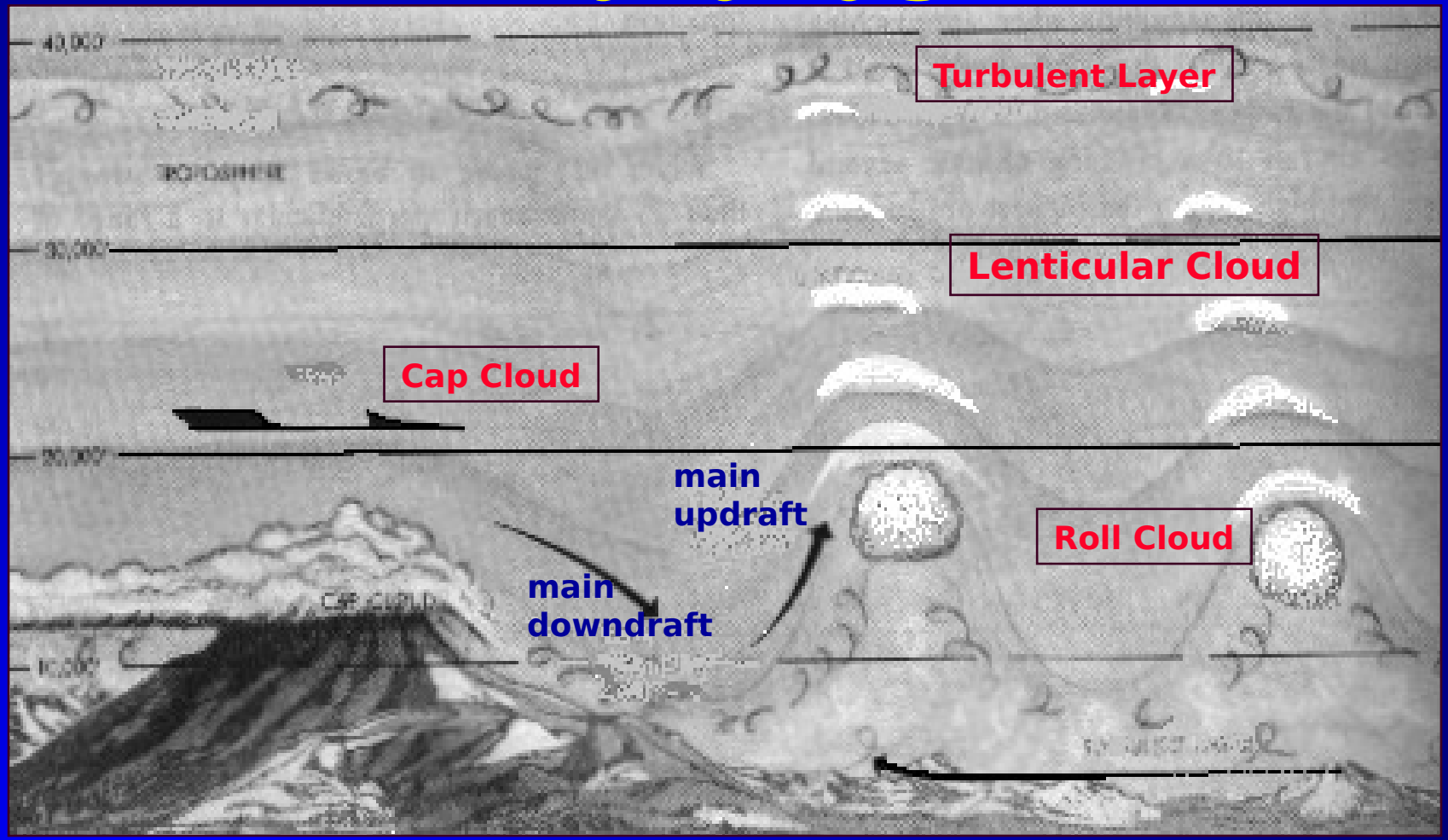
MOUNTAIN WAVE TURBULENCE



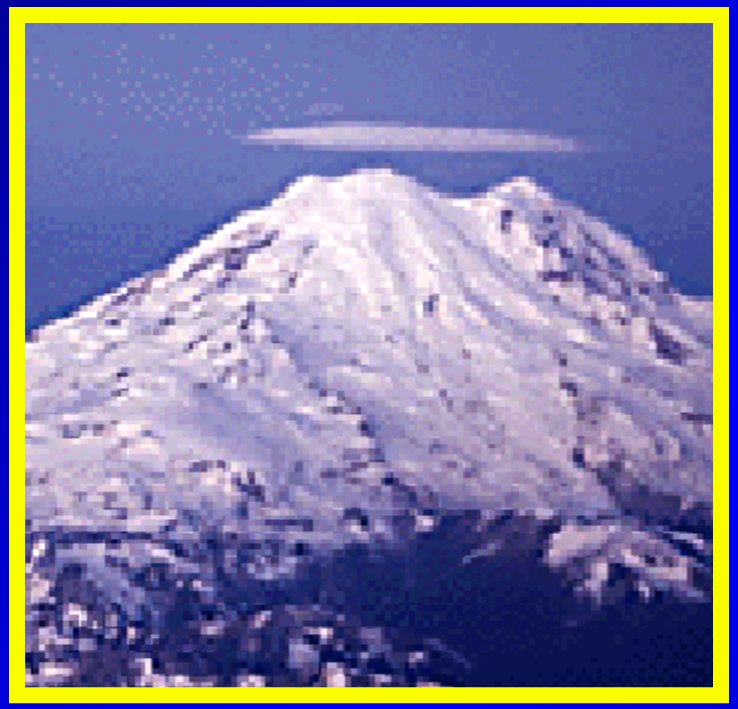
Visual Clues of Mountain Wave Turbulence

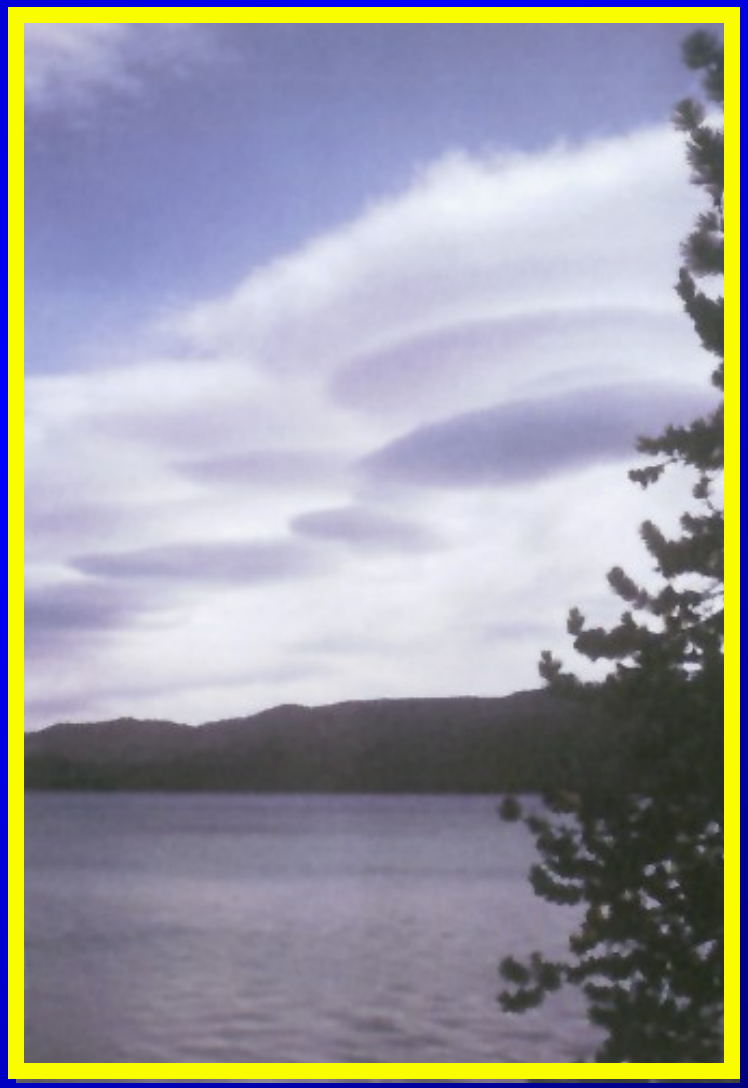
- **Cap Cloud - A low hanging cloud which can obscure the mountain top.**
- **Rotor Cloud - Gives a visual appearance of turbulence. It forms in lines parallel to the ridge on the lee-side of the ridgeline.**
- **Lenticular Cloud - Is a lens-shaped cloud that most frequently is associated with mountain wave conditions. They're usually found 20,000' above and leeward the mountains, sometimes layered.**

Visual Clues to Mountain Wave Hazards

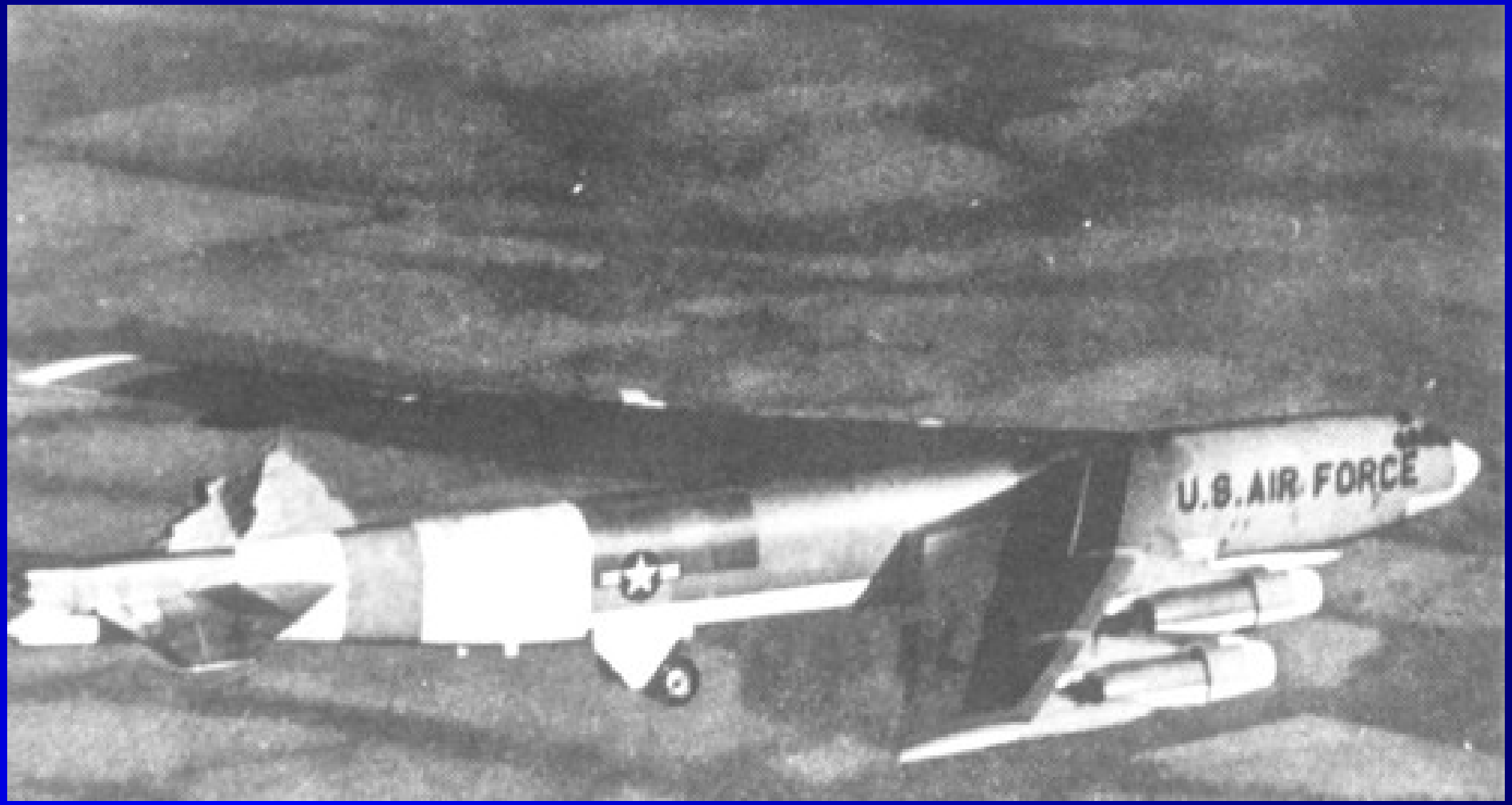


Standing Lenticular





Results of Mountain Wave Turb



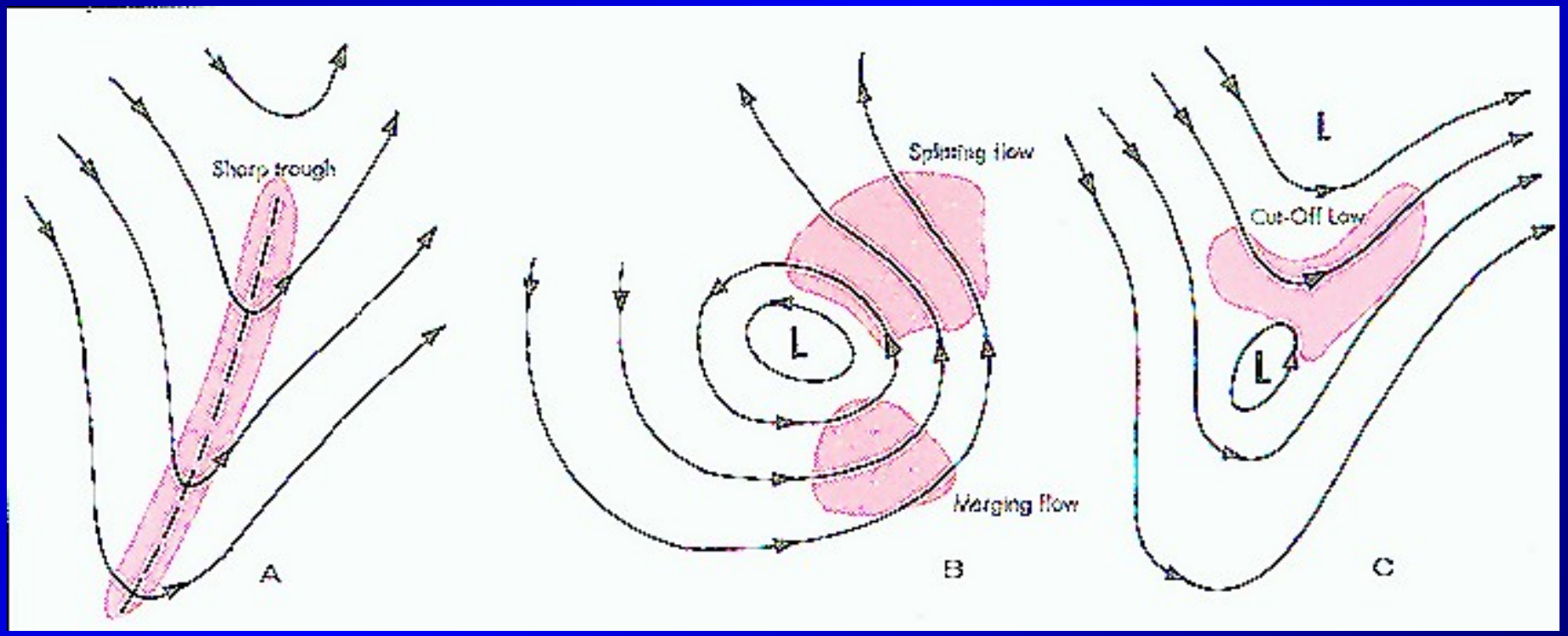
Turbulence Avoidance Procedures

- Avoid cap, rotor, and lenticular clouds
- Fly at a level at least 50% higher than the height of the mountain range
- Approach mountain ranges at a 45° angle, so a quick turn can be made if a severe downdraft is encountered
- Penetrate areas at recommended airspeeds

Clear Air Turbulence

- **Is primarily caused by the jetstream and changes in the overall upper level wind pattern.**
  - Primarily in vicinity of Jet Stream
  - In or near a sharp trough aloft
  - In or near a upper level low
  - The most significant turbulence is w/in 5,000 feet of the jet core.

CAT Common Locations



Turbulence *Avoidance* Procedures

- **Change altitude or course**
- **Fly recommended turbulence penetration airspeed**
  - **–When Jet Turbulence is encountered**
  - –If outside air temperature is rising CLIMB
  - –If outside air temperature is falling DESCEND

WINDSHEAR

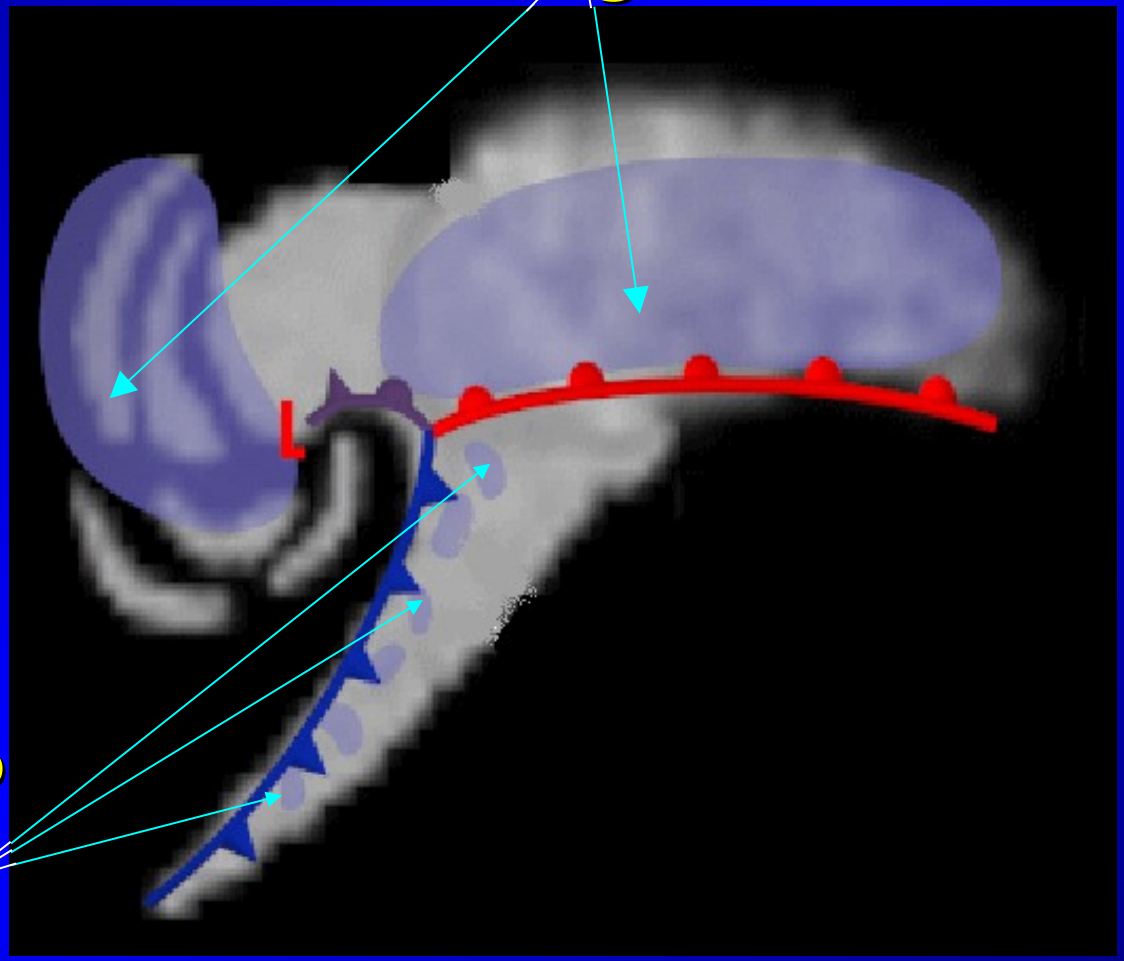
OCCURS NEAR:

- INVERSIONS
- FRONTAL ACTIVITY
- CONVECTIVE ACTIVITY
- JET STREAMS

CAUSES TURBULENCE

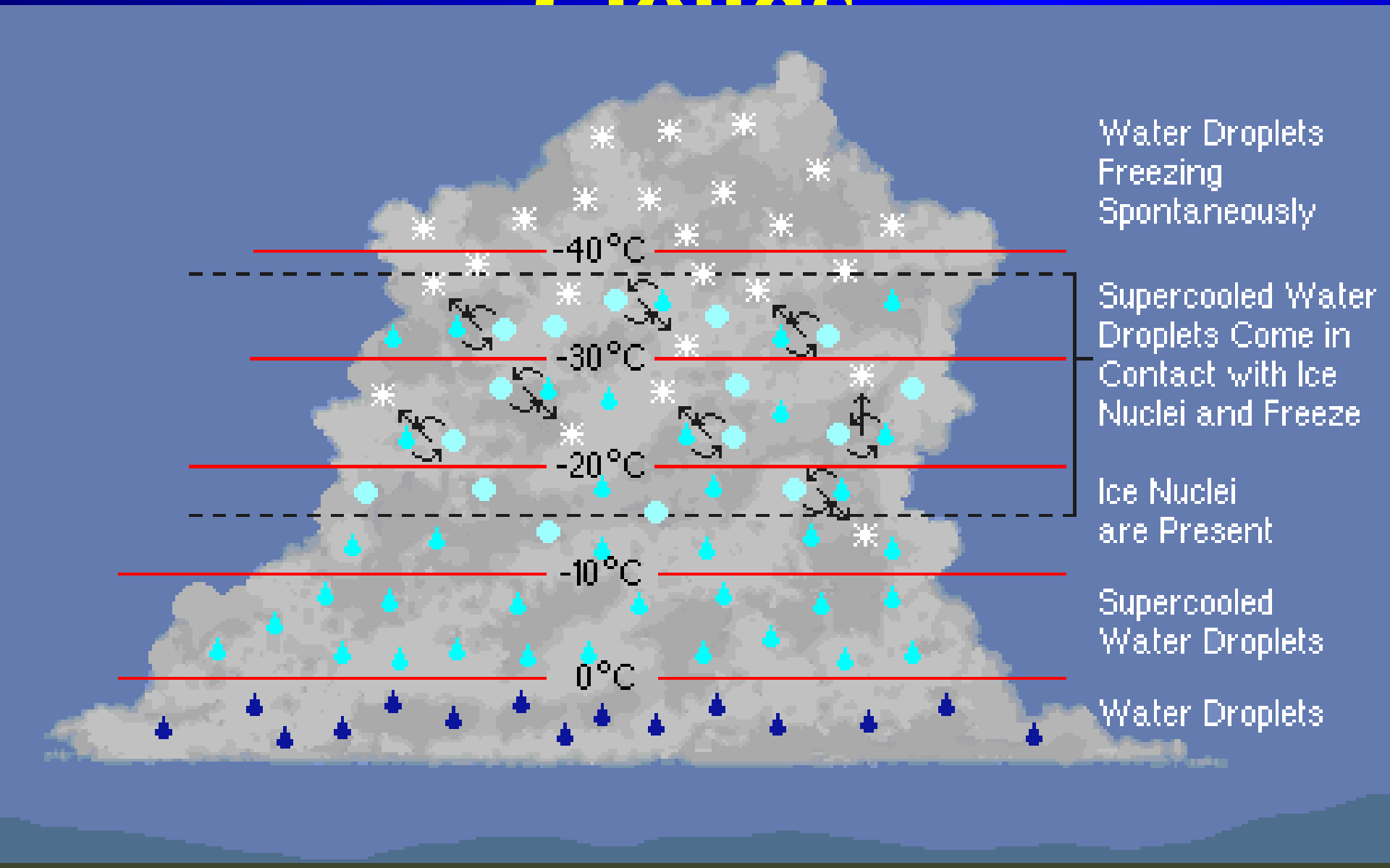
ICING: FAVORABLE REGIONS

Primary Formation Regions



Secondary Formation Regions

Icing Location In Clouds



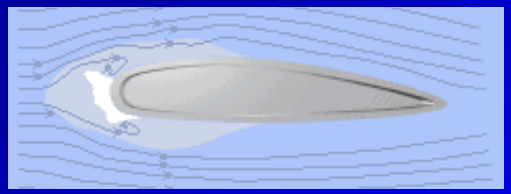
ICING TYPES

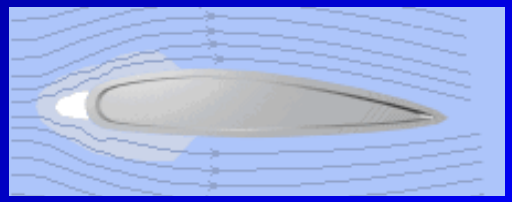
- Rime
  - Milky, bumpy coating
  - Usually from stable precip
- Clear
  - Clear, smooth coating
  - From cumuliform/freezing precip.
- Mixed

Structural Icing

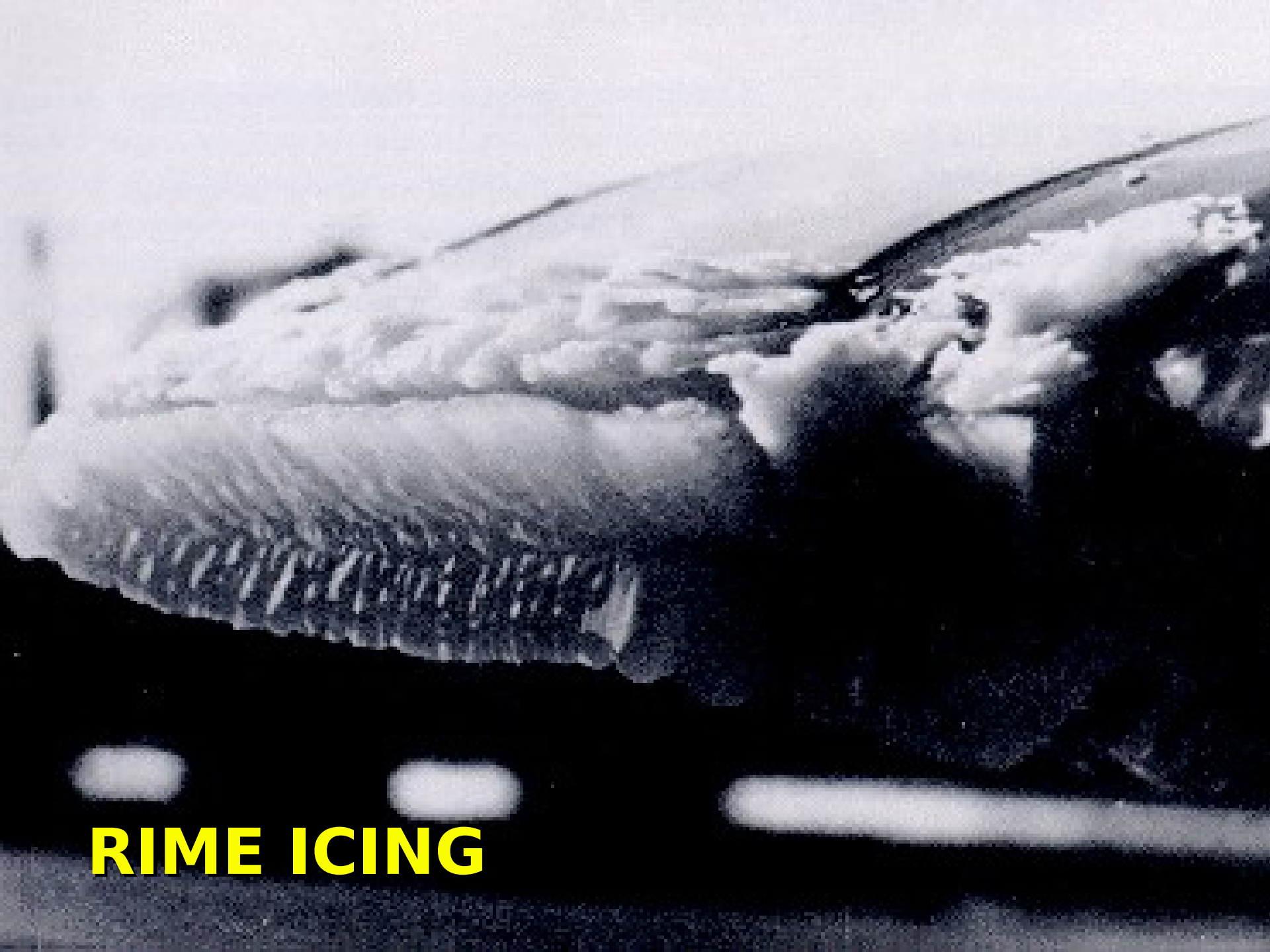
- *Conditions needed for Structural Icing*Free-air and aircraft surface temperatures must be below freezing
- Presence of supercooled visible water droplets or high humidity
- Normal range
  - 0°C - -20°C
  - 0°C - -40°C in Thunderstorms

Types of Structural Icing

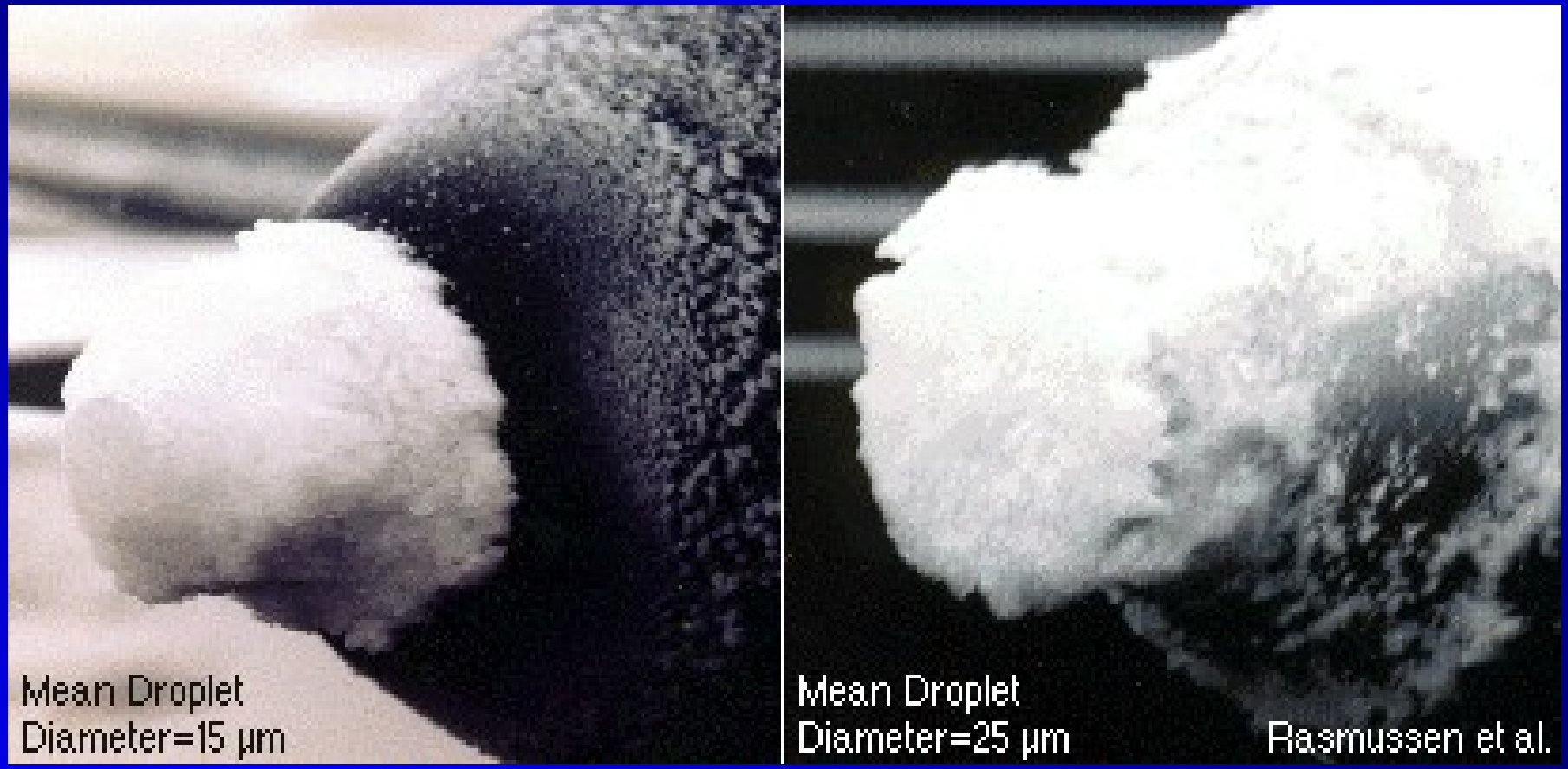




- **Clear Ice -** “Glossy Ice”
- **Rime Ice** - “Milky Ice”
- **Mixed Ice -** “Combo Ice


RIME ICING

Difference Between Large and Small Droplet Size



Associated Hazards

- Reduces lift and thrust
- Increases weight, drag and stall speed
- Can hamper the operation of control surfaces
- Reduce cockpit visibility
- Disrupt radio communications
- False readings on airspeed, altitude

Avoid or Minimize Icing Effects

- Remove all ice and snow before takeoff
- Use all anti-ice / de-ice equipment
- Climb to temps colder than -20^{o} C or Descend to temps warmer than -10^{o}C
- Send pilot reports (PIREPS) of any icing encountered or if it is forecasted and none is encountered

WATCHES, ADVISORIES, AND WARNINGS

DEFINITIONS

Weather Watch - A special notice that alerts you of a potential for weather conditions of such intensity as to pose a hazard to *life or property* for which you must take protective action.

Weather Warning - A special notice that alerts you to weather conditions of such intensity as to pose a hazard to *life or property*.

Weather Advisory - A special notice that alerts you to weather conditions that could affect your *operations*.

OBSERVING AND TAF CODING

OBSERVATION CODING (METAR)

Example observation:

KSKF METAR 1055Z 21019G27KT 3 -TSRA FEW020CB BKN045 BKN250 35/28 ALSTG 29.92

Current weather break down: (Common to local area)

- (light) **BL** (blowing) **RA** (rain) **PO** (dust devils)
(moderate) **SH** (showers) **PE** (ice pellets) **SQ** (squalls)
+ (heavy) **TS** (Thunderstorm) **GR** (hail) **FC** (funnel clouds/
VC (in vicinity) **GS** (small hail) tornado)
SS (sandstorm) **DS** (duststorm)

FORECAST CODING (TAF)

KSKF FCST 14-14 18015G25KT 7 -SHRA FEW020CB BKN040 ALSTG 29.84 VCTS

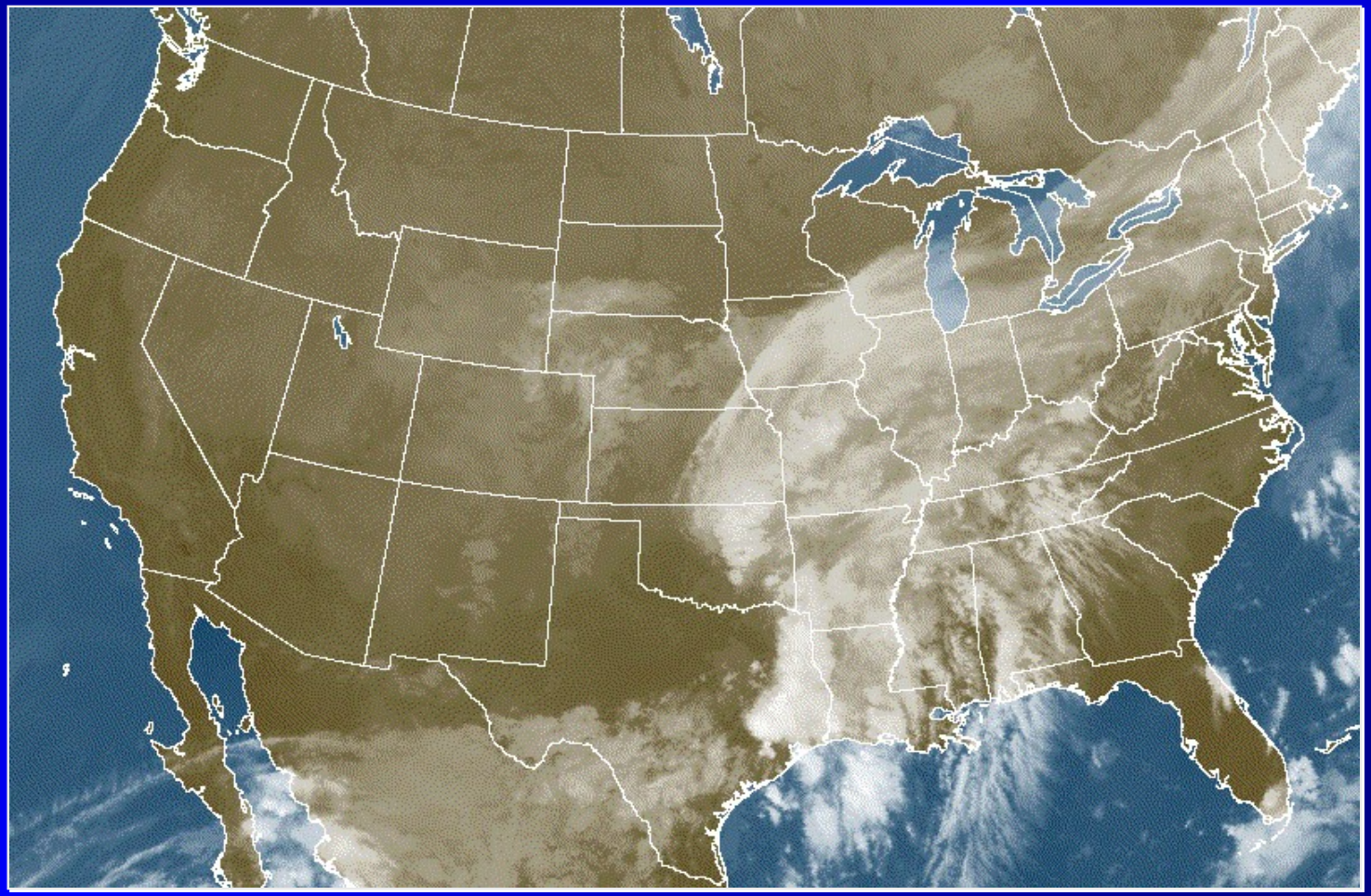
TEMPO 18-22 VRB20G40KT 3 TSRA BKN050 LGT RIME ICG 050-100 LGT TURBC SFC-090

BECMG 00-01 18012KT 7 NSW SCT050 BKN150 BKN250 ALSTG29.88INS T33/23Z T22/14Z

WEATHER EQUIPMENT and SOFTWARE

SUPPORT EQUIPMENT

SATELLITE



WSR-88D

- LOCATED 35 NM Northeast OF SKF
- COVERAGE EXTENDS OUT TO 248 NM FOR TOTAL RANGE COVERAGE

LIMITATIONS

- WITH LOWEST ELEVATION ANGLE OF .5 DEGREES, THE RADAR BEAM IS ~ 3,600 FT ABOVE SKF
- UNABLE TO GET DATA BELOW LOWEST ELEVATION ANGLE
- MAKES A GREAT LIGHTNING ROD, SO SOMETIMES THE RADAR IS DOWN WHEN WE NEED IT MOST

NATIONAL LIGHTNING DETECTION NETWORK (NLDN)

- 106 REMOTE GROUND BASED SENSORS THROUGHOUT CONUS
- ONLY DETECTS CLOUD-TO-GROUND FLASHES NOT CLOUD-TO-CLOUD FLASHES
- DETECTS 92% OF CLOUD-TO-GROUND LIGHTNING FLASHES
- LIGHTNING FLASH DISPLAYED WITHIN SECONDS OF FLASH
- LOCATION OF FLASH ACCURATE TO WITHIN 1500 FT

Products Available on the Web Page

Internet Address:

https://ows.barksdale.af.mil

Products:

- Current Wx
- Fcsts/Hazards
- Warnings
- Satellite/Radar
- 5 Day Outlook
- Climatology
- Lightning Display
- Tropical Info
- Unit Tailored Page

HOW CAN YOU HELP?

BRIEFINGS

2 Hour Notice
Have The Following Pertinent Info On H

- **Brief Time, Location, POC**
- **Flight Call Signs, Number Of Aircra**
- **Take-off And Land Time**
- **Route Of Flight**
- **Range And Refueling Times/flight L**
- **Alternates**

TRANSIENT BRIEFINGS

During weather non-duty hours or if service is delayed due to higher priority taskings, please contact the 26 Operational Weather Squadron (OWS) for support.

Telephone Numbers:

DSN: 781-4775
Commercial: (318) 456-4775

Toll Free: 1-866-223-9328

FAX: FAX - DSN: 781-3493

COM: (318) 456-3493

AIR FORCE WEATHER REENGINEERING

Operational Weather Squadrons